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The American Biology Teacher

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Pupil-Teacher Planning in Biology

CHESTER F. PROTHEROE
Beaver Country Day School, Chestnut Hill, Massachusetts

Attempting to predict the outcomes of a new course, before experimenting with it for at least a year, is a rash venture at best. Your editor has asked me to describe the procedures which I am planning to use with my biology class at the Beaver Country Day School during the coming year. As I have been promised the opportunity of presenting another report on the experiment near the end of the school year, I shall not attempt predictions but shall apply the patent medicine idea and try to draw two pictures of the situation, "before and after taking." Whether in the later article I shall look back with pride or with chagrin on my present high hopes is on the knees of the gods.

For some years many biology teachers have been dissatisfied with the conventional course in that subject. Our textbooks and our classroom procedures have blandly assumed that we knew what our pupils should study about living things. Our adult minds, conditioned by our own preparation in this field, have accepted the premise that pupils should be informed about the great phyla of plants and animals, especially as they affect man. Those teachers who have been more sensitive to the problems of motivation and pupil interest have taken great pains to sugar-coat the pill, but the essential prescription for the dose has remained the same. Never, so far as I know, have we honestly consulted our pupils' interests and needs as an appropriate consideration in the planning of a biology course.

Last summer I addressed myself to the problem which might be phrased, "What are the present and anticipated needs of tenth grade pupils, to the satisfaction of which biological material can contribute?" Perusal of the science report of the Commission on the Secondary School Curriculum of the Progressive Education Association (1938) suggested four main categories of problems confronting pupils. These are (1) problems of understanding one's self, (2) problems arising in personal contacts with other people

and living things, (3) problems involving civic and social responsibilities, and (4) problems relating to vocational adjustments.

Whether any adult can successfully reinvest himself with the mind of a sixteen-year-old is very dubious. However, this is what I next attempted to do. With the four types of problems in mind, I tried to formulate questions which my students might ask, and which biology might help them to answer. Having evolved a considerable number of questions, I worked out a series of generalizations that could be developed from the answers to these queries. Space does not permit me to reproduce more than a skeleton outline, devoid of questions and generalizations. The experienced biology teacher will readily recognize what specific subject matter can properly apply to the various headings. The reader should bear in mind that sets of questions and generalizations were formulated which applied to each subheading, such as diet, cleanliness and sanitation, philosophy of life, mechanism of heredity, etc.

Analysis of the Individual's Problems

1. The need to understand one's physical and mental self.
   - 1.1 What factors contribute to maintenance of good physical health?
     - 1.11 Diet
     - 1.12 Cleanliness and sanitation
     - 1.13 Exercise and rest
     - 1.14 Understanding causes of disease, preventative and curative measures
     - 1.15 Heredity—generalized
     - 1.16 Heating, lighting, ventilation
     - 1.17 Clothing
   - 1.2 How may one maintain good mental health?
     - 1.21 Good physical health, endocrines, etc.
     - 1.22 Philosophy of life
     - 1.23 Interests and satisfactions
     - 1.24 Variation and normality
2. The need to understand one's status in the world of living things.
   - 2.1 What relationship does man, the animal, bear to other living things?
     - 2.11 Plant and animal evolution
     - 2.12 Mechanism of heredity
     - 2.13 Interdependence of plants and animals, with special reference to man
   - 2.2 What can man do to preserve and improve other living things for his own benefit?
     - 2.21 Conservation of wild life—plants and animals
     - 2.22 Breeding for improvement of species
       - 2.221 Esthetic values
       - 2.222 Practical values
   - 2.3 How may one get along well with other people?
     - 2.31 The individual's changing status in the family
     - 2.32 Parental authority and individual initiative
     - 2.33 Friendship
     - 2.34 Selection of mate
3. The need to understand one's responsibility to the community.
   - 3.1 What can the individual do to obtain and maintain desirable community conditions?
     - 3.11 Public sanitation and health
     - 3.12 Public safety
     - 3.13 Organization for civic betterment
     - 3.14 Contribution of science to community living

4. The need to understand one's position in the economic world.
   - 4.1 How has the present economic organization grown up?
     - 4.11 Subdivision of labor, exemplified by social insects
     - 4.12 Growth of communities
   - 4.2 How may the individual buy wisely?
     - 4.21 Analysis of goods
       - 4.211 Disinterested surveys
       - 4.212 School laboratory
     - 4.22 Analysis of advertising
   - 4.3 How has science contributed to the improvement of man's environment?
     - 4.31 Conservation of natural resources
     - 4.32 Greater comfort and safety due to utilization of materials
     - 4.33 Understanding of natural forces
     - 4.34 Agricultural improvement
   - 4.4 What new problems have resulted from technological advances?
     - 4.41 Safety hazards
     - 4.42 Nervous strain of fast tempo
     - 4.43 Need for planned leisure activities

But what of pupil-teacher planning? The reader who at this point refers to the title of this article will doubtless suspect the presence of a dark-complexioned gentleman in the combustibles. He may chuckle, "Oh, yes, another pupil-teacher planned course that is really the result of more or less subtle suggestion by the teacher, who knows what he wants to teach and tries to fool his pupils into thinking that they have done the choosing. An interesting outline, perhaps, but the pupils haven't planned it."

I frankly admit that such cynicism would be amply justified if (and here lies the crux of the matter) the outline were distributed to the pupils or used by the teacher as a definite series of topics to be discussed during the year. My only purpose in including it in this article is to show the results of an exploration into the possibilities of applying biological material to the solution of problems that might be suggested by pupils. Most emphatically I repeat that it is not intended to be used by the pupils or by the teacher as a formal course of study. In other words, I feel that it would be presumptuous for me to attempt to lay out in advance a course which would meet the needs of a particular group of students, and I therefore regard the outline as merely background material suggesting to the teacher possible areas in which student problems may profitably be grouped.

Now let us consider the approach to a genuine pupil-teacher planned course. Last spring, in preparation for the coming year's work, I tried to head off any preconceived expectations as to the specific content of biology by telling prospective students in the course that I did not myself know what we would do in the fall. I told them that the course would be organized by the cooperative efforts of pupils and teacher, around the questions which they themselves suggested, and which biology could help them to answer. This fall I shall reiterate to my class this same statement of point of view.

Then, through committees of students, through unsigned questionnaires, and through suggestions by individuals, I expect the problems which are of genuine concern to this group to emerge. We shall then analyze and attempt to arrange them in related groups, after

which we shall work cooperatively in solving them and developing generalizations wherever possible. In this way the year's work in biology will proceed, through the pooling of effort by pupils and teacher, with the pupils taking the lead in suggesting questions to be investigated and with the teacher acting as a tactful guide (but not as a pourer-out of facts).

Critics of pupil-teacher planning sometimes raise the objection that immature pupils, because of their lack of experience, cannot anticipate future needs about which certain courses should give them information. I recognize the validity of this objection, and I feel that it is legitimate for the teacher to lead the thinking of his pupils in the direction of such adult problems as they are competent to discuss at their present ages. However, I consider that the immediate problems suggested by students should have prior claim on class time. The successful solving of present problems, provided they are genuine and vital, helps the student to develop security in his personal and social life. Consequently, in his later attack on adult problems, he understands the problem-solving method and he approaches these maturer questions with a consciousness of power which is inherent in the personally well-adjusted individual.

Genuine pupil-teacher planning may be likened to a sensitive plant. It must grow in the soil of mutual confidence and it must be gently handled, else it will wither and die. Pupils must be certain that the teacher is not trying by subtle means to "put something over," but that he means what he says when he invites them to take the initiative in planning the work of the course. The teacher must show his confidence in the pupils' sincerity, good faith and common sense in proposing and working on problems. Furthermore, the problems of youth are often hedged about by emotional inhibitions, and therefore must be tactfully coaxed forth for consideration.

Some of my readers may object that I have shot too wide of the mark in proposing to make a general problems course of my biology class. They may point out that many of the problems suggested in the outline might more appropriately be discussed in other subject classes. There are at least three answers to these objections. While at Beaver we are not closely confined to conventional subject matter in our various courses, in most schools it is true that the problems approach is so new that most courses are still organized on a strictly subject matter basis. Secondly, it is my purpose to approach questions proposed by pupils from the point of view of what biological material can contribute to their solution. Finally, inasmuch as biology is the science of living things, I consider that its most appropriate application is to the self-adjustment of those forms of life in the classroom, the students themselves.

Due to the difficulties attendant upon an experiment of this kind, there is considerable trepidation mixed with the high hopes with which I approach my experience with a pupil-teacher planned course in biology. I shall welcome correspondence with other teachers in the field who either have tried, are trying or wish to try procedures of this general type. Next spring I shall offer a report of outcomes, which I hope may take the form of assurance that the sensitive plant has flourished, despite some inevitably erroneous procedures in its care.

The Relation of Mating or Breeding Times of Animals to Light or Length of Day

THOMAS HUME BISSONNETTE
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"In the spring a fuller crimson comes upon the robin's breast;
In the spring the wanton lapwing gets himself another crest;
In the spring a livelier iris changes on the burnished dove;
In the spring a young man's fancy lightly turns to thoughts of love."
—*Locksley Hall.*

Introduction

The changes pointed out so aptly by Tennyson in the above passage are closely related to mating times and behavior of the animals mentioned and many others of like kind could be listed. Northward migrations of birds from near the equator or even across it, the taking up of territories by migrant birds, courtship rituals, and the fighting of males for the preference of females are all phases of the same great fundamental cycle of internal rhythmical functions of the birds, concerned with the adaptations of the times and places of breeding to success in rearing the succession of generations which must continue the races. The return from the north toward the equator or across it as the northern winter approaches is the obverse of this process and completes the cycle for such birds. Not all birds migrate; not all are seasonal in their breeding; and some have two or more cycles each year; some breed in spring, some in autumn or winter.

Birds are not alone in exhibiting such seasonal times of breeding or mating. They are shown by mammals, like ferrets, raccoon, cotton-tail rabbits, deer, sheep and goats; by some fish, like brook trout, stickle-backs, minnows, killie fish; and by some amphibians and reptiles. The same variations in response are shown as among birds. Plants also show similar cycles of flowering related in different ways to the seasons.

In the brief space of this paper we cannot go into and discuss all the factors in the environment that have been found to act as trigger-release stimuli to set off, accelerate, or retard these cycles of mating and reproductive activity. We shall, therefore, mention only some of them and confine our discussion to the results of experiments on vertebrate animals, particularly birds, with some description of the methods of research used to find out what factors are concerned and how they act. We must keep in mind, however, that many invertebrate animals also show such cycles, with them, also, related to environmental factors.

Historical Background

In 1698, Martin said in *A Voyage to St. Kilda* (London), "The inhabitants observed that when the April moon goes far in May the fowls (sea birds) are ten to twelve days later in laying their eggs than ordinarily they use to be." This

may suggest a summation effect of lengthening days and waxing moonlight upon the incidence of breeding of sea birds of the islands.

In 1803, Dieste, in Madrid, described the practice in Spain of waking up the hens with lights in the henhouse to feed them at night. This resulted in autumn and winter laying, which he attributed to the increased food consumption permitted by the added periods of light. Waldorf in 1895 appears to be first to use night-lighting to induce laying of poultry during autumn and winter in this country and by 1920 almost all commercial poultrymen in many states were practicing it. They either agreed with Dieste or believed that added periods of scratching for food or muscular exercise were the fundamental factors inducing increased reproductive activity.

In birds, migrations are closely correlated with the breeding cycle. In 1907, Sharpey-Schaefer, on purely theoretical grounds, suggested that migrations were probably caused by some very regularly recurring environmental stimulus. He suggested that the most regular of the changes with the seasons was the regular change in length of day recurring each year and that it is the variable controlling the migration cycle. He did not think it was determined by the changes in the sex-glands as a mediator of the stimulus. Eifrig in 1924 agreed with this idea.

Before 1925, Professor Rowan of the University of Alberta began studies on relation of changes in length of day to migration of the snow bird (*Junco hiemalis*) to test experimentally the suggestions of Shaefer.

Experimental Studies

Birds

By a series of experiments carried out in open cages in winter during which the temperature sometimes went as low as $-50°$ F., he showed that reversing the daylight curve in autumn and winter, by electric lighting after night-fall in increasing periods, would cause juncos, canaries and crows to produce sperms in winter instead of at the normal breeding season in April or May. In juncos and crows, he concluded, this activation and enlargement of sex-glands was correlated with tendency to migrate north and that regression of the glands was correlated with southward migration. This could be brought about by shortening the daily exposure to light. Adding and then withholding light induced breeding condition of the sex-glands four or more times a year. His interest was primarily with the relation of migration to cyclic seasonal changes in length of day. He concluded that the migration urge is dependent on the cyclic changes in the sex-glands and called this response "photoperiodism" after Garner and Allard who had previously discovered such a relation of blooming in plants to length of day.

We are not interested primarily in the migration problem, but in the relation of the sex-glands and related glands of internal secretion to changes in length of day. Nevertheless, from our studies on starlings, pheasants, bob-white, blue jays, ferrets, raccoon and cotton-tail rabbits and those of others on mourning doves, sparrows, starlings, mejiros, ducks, turkeys, grouse, ptarmigan, field mice, white-footed mice, hedge-hogs, brook and rainbow trout, sickle-backs, minnows, killie fish, etc., and some of Rowan's data on castrate crows, and Hann's on juncos, towhees and white-throated sparrows, it is suggested that migration urge, togother with sex-gland changes, originates in changes of activity of the anterior lobe of the pituitary gland, at the

base of the brain, induced or modified by changes in the stimulus through the eyes and optic nerves. It is known to control activity of the sex-glands and, through them, secondary sexual apparatus and behavior. Migration is evidently an early phase in the drive toward mating reactions in spring and in reaction from them in autumn. The bases for this suggestion may be more evident after some of these studies are described.

Rowan, apparently influenced by the ideas of the poultrymen mentioned above, and as the result of a fragmentary and incomplete experiment, using increased forced exercise with reduced lighting periods on a few juncos already well advanced in sex-gland activation in March, stated, "It would thus appear that radiation may be definitely eliminated and that increasing exercise suggests itself as being responsible for the recrudescence of the organs of the junco. The extra consumption of food, for reasons discussed elsewhere, is of questionable significance." He has lately abandoned the idea of exercise for "wakefulness or physiological activity." Results of recent work support the statement as to the relative unimportance of amount of food consumed above a minimum to prevent inanition. But it is evident that limited quality or variety of food may act as a limiting factor and plays an even more important rôle in some cases. Studies on birds, mammals and amphibia rather indicate that larger consumption of food is the result of increased reproductive activity, not its cause.

Since 1926, the normal sexual cycle of the European starling has been studied in our laboratory at Trinity College, Hartford, Connecticut; a bird as yet migrating but little in America, but forming large flocks in late summer and autumn and roosting around buildings and in trees in the city at night. Sex-glands of both sexes have been checked histologically at bi-weekly intervals from November to May and those of the male from May to November, in two successive years and once or twice later. Some regularly recurring environmental cycle most closely correlated with the observed regular cycle of sex-gland activity was sought. Of them all, the only really regular one was the cycle of change in duration of daily hours of daylight with the seasons.

Rowan's studies on the junco came to our attention and his theory that changes in periods of muscular exercise were the fundamental cause of the sexual changes in birds rather than changes in exposure to light flux did not seem to be the only explanation compatible with his data nor reasonably proven. So increasing exercise without increasing light-time was checked against added light without forced exercise and against no added light or exercise, using apparatus similar to Rowan's with improvements to increase its effectiveness. This apparatus disturbed the birds from the roost and floor at intervals of twenty seconds for periods after dark of the same duration as those during which light from a 60-watt bulb was thrown into the cage used for testing light-effectiveness. These periods were gradually increased up to seven hours each night. Experiments were carried out from December 4 to April 30.

Increasing exercise without increasing light failed to induce activity of sex-glands and actually reduced such activity and the size of these glands. Increasing light, on the contrary, proved to be a potent stimulator of the sex-glands and germ cells of male starlings and incompletely so for females. Modifications of

the method of experiment and of the previous lighting and sexual conditions of the birds used indicated that increasing periods of exercise led to a lag in onset of testicular changes induced by changes of lighting conditions, whether these were increase of activity induced by increased exposure to light or decrease or regression resulting from reduced lighting. The delay in activation or inhibition due to this lag or prolonged refractory period was usually over-compensated for later by an acceleration of the changes in the testes once these had begun.

Exposures to light after sundown, up to six or more hours each night, led to production of mature sperms and maximum size of the testes (sometimes greater than the normal spring maximum) in from four to six weeks at any time between November and May. The nearer the spring normal breeding season the shorter the number of days required, and vice versa. Controls, subject to short periods of light only, failed to come into activity even in April, May and June, when in nature the testes reach and pass their climax of activity and size. The state of testis activity (and of ovarian, within certain limits, as judged by gross inspection at autopsy) can be modified at will in either direction, within the limits of their natural changes, by increasing or decreasing daily periods of illumination. Some birds could be kept for a month or more in a condition of partial regression (or activation as since shown by Burger) by holding constant their daily periods of light and exercise, once their increase or decrease of activity was stopped by the constant light period, if this was between the limits of duration required to induce complete activity or to suppress it. These limits, Burger has since shown, are between nine and a half hours and fifteen or sixteen hours each day.

The next experiments showed that the rate or degree of activation of testis activity varies with the intensity of illumination used, up to a limit. Birds lighted by 10-watt bulbs were slower to reach maximum activity than those with 15-watts and than those with 25-watt ones and so on. Birds with added periods of both light and exercise were later in beginning activation than those with added light periods alone; but later overtook those with added light of similar intensity. Optimum intensity or duration of added light have not yet been accurately determined although Rowan mentions in one of his papers that he found the former for juncos. Yet he does not state it in any recognized units nor the light sources or distance used.

The degree of stimulation for starlings depends also on the color or wave-length of the light used. Red is very highly stimulating; green of equal intensity for equal daily periods was not stimulating at all but permitted some exercise which, like that in forced exercise experiments, tended to slightly reduce the size and activity of the sex-glands. Violet light also fails to induce activation, like green. White is stimulating in proportion to the red or similar long-waved light emitted. This has since been confirmed for ducks by Benoit in France. The birds behave similarly in all four types of light and certainly are kept awake for the same lengths of time. Yet one type of light is activating while others are not. Neither periods of exercise, wakefulness, or physiological activity (Rowan) differ for the birds under the different lights, except those of the latter resulting from the stimulus of certain wave-lengths of light; yet the results are different. Rowan has either

ignored this or suggested the results are faked; he has made no attempt to fit either our results or those of Benoit on the duck into a theory of sexual activation. The above differences in effect are not due to differences of heat or total energy received but to an apparent wave-length specificity. Marshall and Bowden of Cambridge have shown this specificity of wave-length is not true of all animals. They found that ferrets are apparently equally stimulated by all wave-lengths of the visible spectrum from near infra-red to some wave-lengths in the ultra-violet, if intensities and durations of exposure are equal; but not beyond those limits.

For starlings, daily period, intensity, and wave-length of light condition sexual cycles if diet is varied, adequate, and rich in vitamins, proteins, salts and fats. But improper food, even in sufficient quantity, may limit or prevent this effect by even highly stimulating exposures to light. This suggests a possible factor conditioning reproductive cycles in the tropics where lighting changes are minimal.

No mating or egg-laying occurred among starlings brought to complete sexual activity as judged histologically. These activities appear to be conditioned by factors not operating in these experiments, such as posturing of mates, freedom to make nests, the sight of other birds mating or extension of territory. In pigeons, the image of the bird itself may be enough to induce laying which fails to occur with solitary birds, as studied by Matthews at Cambridge. Professor L. J. Cole, however, by similar methods, induced mourning doves, which will breed in captivity, but not during autumn and winter normally, to mate and lay viable eggs in winter. Outside of poultrymen he was first to do this.

With male starlings maximum and consistent effects were results of large and immediate increases in daily periods of night-lighting rather than of gradually increasing periods, even in autumn when daylight periods were decreasing. Filtered red light, of 1.7 foot candles intensity, acting for six hours each night from the start, after daylight periods gradually decreasing with the season to nine and a half hours per day in a basement room, induced complete spermatogenesis in 23 days in December and January. Other light combinations including red did it in eighteen days.

Regression of the testes in starlings invariably occurs normally before June 8 to 15, for no birds killed on or after those dates had remained in complete activity, although day-lengths are increasing up to June 21 in both duration and intensity. Experimental studies show that, no matter how potent the light schedule used, the birds invariably pass the climax of sex-gland activity and size after a time and undergo regression. This regression is due to some "throwing out of gear" of some part of the reproductive mechanism or the development of a refractory state to the hormones increased by the lighting schedules. This refractoriness to sexual stimulation by light also occurs in ferrets under experimental conditions. It is also shown by birds shortly after their normal cessation of reproductive activity in late summer and they then require stronger stimulus of light or longer time to be activated, or both. The condition gradually decreases later and the birds are easier to activate in November and December. Less stimulus is needed, the nearer the normal breeding season is approached. In many cases the action of injected hormones show similar development of refractoriness. Some think it

(Continued on page 74)

Second Annual Convention

of the

NATIONAL ASSOCIATION OF BIOLOGY TEACHERS

in conjunction with

The American Association for the Advancement of Science

meeting at Columbus, Ohio
Christmas Week, 1939

Program

Executive Board will meet **Dec. 28, 1939**

at 4:30 P.M. at The Neil House

General Meeting for Members and Friends **Dec. 29, 1939**

at The University School Building
Room 100

Morning Session 9:30 A.M. to 12:00 Noon

Speaker	Topic
A. O. Baker	Science Trends in the East and West
Kenneth B. Crooks	The Use of Mnemonics as Aids in Biology Instruction
Ed. C. Jeffrey	New Light on the Physical Basis of Heredity
N. E. Bingham	Teaching Nutrition in Biology Classes of the Secondary School Level

Afternoon Session 2:00 P.M. to 4:30 P.M.

J. P. Visscher	New Light on Barnacles
Henry B. Ward	Biology Teaching and Conservation
Thomas Smythe	Biology and the High School Science Sequences
Glenn W. Blades	The Preparation and Use of Botanical Materials for the Biology Classes
H. H. Rostorfer	The Problem Approach in the Teaching of Biology
Homer Stephens	The Proposed Program of the Kansas Biology Teachers Association

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Headquarters will open at **The Neil House on December 26, 1939**

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SURVEY OF HIGH SCHOOL BIOLOGY

Our readers already know that this journal, and also our National Association of Biology Teachers, are an outgrowth of efforts initiated by the Committee on the Teaching of Biological Science appointed by the Union of American Biological Societies. That very active Committee is financed sufficiently to enable it to do further important service to the teaching of biology at both secondary school and college levels. At this moment through a nation-wide questionnaire, addressed to teachers of high school biology, it is seeking the information that will guide all its later efforts. You and your biological colleagues who are not members of the N.A.B.T. should have received that questionnaire late in November. The Editor thinks that by a full and prompt response to that inquiry every high school teacher of biology can share importantly in the task of giving more and better biological instruction to our people.

NOMINATIONS

for the officers for 1940–41 will be made by a nominating committee to be appointed by the executive board at its meeting in Columbus, Ohio, on December 29, 1939. Nominations will be made for President-elect, First Vice President, Second Vice President, and Secretary-treasurer. Members wishing to make suggestions may do so by letter to the nominating committee, c/o the President or Secretary.

Local affiliated organizations may make additional nominations in accordance with the provisions of section 2 of Article II of the national constitution. Local officers should study the provisions of this section.

NATIONAL ASSOCIATION REPRESENTED ON NATIONAL SCIENCE COMMITTEE

Mrs. Grace L. Cook, biology teacher in the Champaign, Illinois, High School, has been selected by the Executive Board as our representative on the National Science Committee. Mrs. Cook attended the two-day meeting of the committee in Chicago on October 6th and 7th. Mrs. Cook has not been assigned to any of the sub-committees as yet but at Chicago visited all of the working sections of the organization to become acquainted with all of the phases of the committees' work. We can feel that our association is ably represented and that we are taking an active part in the important work of this national group which is working on science education as a whole.

CHICAGO BIOLOGY ROUND TABLE

Perhaps the most authoritative scientific account of The Life History of the Alaska Fur Seal was presented at the December meeting of the Round Table. The title of this was "Ottiga, the Master of the Harem," presented by Mr. C. J. Albrecht of the Field Museum. Authoritative because Mr. Albrecht, a seasoned explorer, zoologist, photographer and animal sculptor, has participated in and directed twenty-two expeditions extending from the Siberian and Alaskan arctic to the jungles of Africa.

Due to the popularity of this lecture the meeting was changed from the Medical and Dental Arts Café to The Women's Club, 72 East 11th Street. It was held at the same time as the usual meetings, which was on December first.

M. C. LICHTENWALTER

Teaching Aids

QUESTIONS ON TECHNIQUE AND TEACHING AIDS

will be answered in this column if the questions are sent to Marcus Lilling, Seward Park High School, 350 Grand Street, New York City.

A SIMPLE DEMONSTRATION OF THE CONDITIONED RESPONSE*

While the technique of establishing a conditioned response is theoretically simple, laboratory manuals usually omit this important principle in their experiments on learning. The reason for the omission is probably to be found in the difficulty encountered in securing unequivocal results within a short space of time by means of equipment ordinarily available.

The writer has regularly employed the following procedure in demonstrating conditioning to groups of students. Because of the ease and speed of the technique, it has been a useful adjunct to lectures on learning. The necessary apparatus includes a golf ball, a screen, consisting of an 8- by 10-inch cardboard clamped to an 18-inch support, and a "clicker" (any device capable of making a sharp click). The subject seats himself by a table upon which he extends his right arm palm downward. The experimenter holds the golf ball in full view about 14 inches above the extended hand and instructs the subject to avoid inhibiting his natural response to the falling ball. Having dropped the ball several times, allowing the subject to withdraw his hand to avoid being hit, the experimenter next drops the ball from behind the screen which is fixed at about the same height. It is important to have the screen so adjusted that the subject has just time enough to respond to the sight of the falling ball. This is the response to be conditioned. The experimenter now makes several clicks from behind the screen as the subject's hand lies extended, and all may observe that the sound by itself elicits no visible withdrawing reaction. At this point the experimenter gives eight to twelve simultaneous presentations of the original and substitute stimuli. This is accomplished by holding the "clicker" in one hand and the ball in the other, both hands being behind the screen. The coordination may take a small amount of practice, but it is easily learned. The click alone is then capable of eliciting the withdrawing reaction. By repeatedly presenting the click without reinforcement from the falling ball, it is possible to demonstrate extinction. A few additional reinforcements can then re-establish the conditioning. Should the subject voluntarily inhibit the conditioned response, the fact may be revealed by dropping the ball without the accompaniment of the auditory stimulus. In this case the ball will strike the extended hand.

W. A. Bousfield
Connecticut State College

* Reprinted from *Science*, July 21, 1939, Vol. 90, No. 2325, page 70.

Trichocysts in Paramecium may be demonstrated by adding a drop of blue-black fountain pen ink to the culture.

Plant Presses can be made from flat boards while old newspapers can serve as driers, if they are changed frequently.

FERMENTATION OF SUGAR BY YEAST

Pour 250 cc. of Pasteur's solution into a glass cylinder. Add 5 grams of compressed yeast. Keep at a temperature of 25° C. Cover the vessel with a glass plate. Pass the gas into limewater a few hours later to test for carbon dioxide. Add a few drops of a mixture of strong potassium dichromate and sulphuric acid to the distillate. A greenish color shows the presence of alcohol.

Pasteur's solution—1000 grams—is prepared as follows: 838 cc. water, 150 cc. of grape sugar, 10 cc. ammonium tartrate, 2 grams each of magnesium sulphate, calcium phosphate and potassium phosphate.

M. L.

A Simple Respiration Apparatus for Use in Studying the Energy Needs of the Body*

N. E. BINGHAM

To really appreciate the energy needs of the body high school pupils should have an opportunity to measure their own energy expenditure under varying conditions. More energy is used by a person when standing than when sitting. Lifting weights greatly accelerates the use of energy. Growth increases the rate of expenditure, and nearly every high school class has in it boys or girls who are growing rapidly and others who are making little change in their stature. It is exciting to discover how much energy one does spend, and to compare this expenditure with that of one's classmates.

Standard equipment for measuring metabolism, such as is used in hospitals, is relatively expensive. A simple device, however, patterned after Benedict's Student Respiration Apparatus, can be constructed, which will enable students to make satisfactory determinations of their energy expenditure under varying conditions. This home-made apparatus is relatively inexpensive. It can be made of:

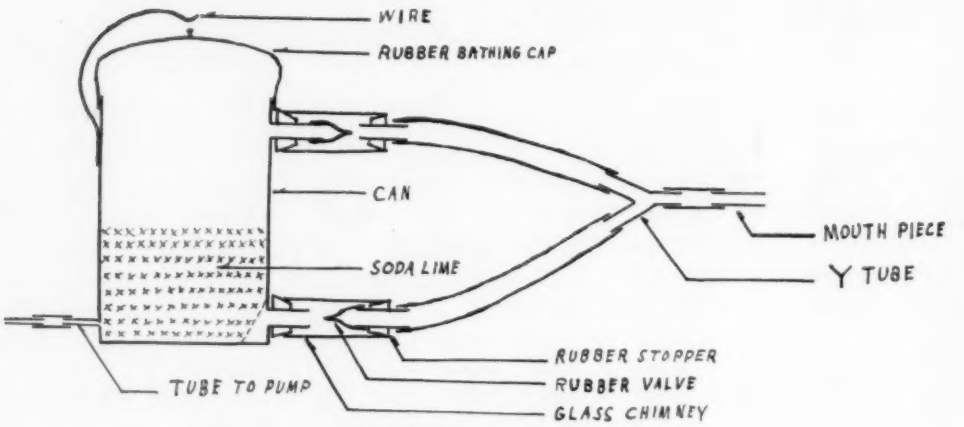
A five-quart lubricating oil can
Three feet of ¾ inch rubber tubing
Some tin and solder and wire
A rubber bathing cap
Two small lamp chimneys or glass housings for valves
Two rubber "gas mask" valves
Four rubber stoppers.

In addition one needs:

Five pounds of soda lime
A laboratory pump (bicycle pump will do)
Small tank of oxygen (desirable but not essential)
Rubber tubing for connecting oxygen tank and pump
A pinch clamp.
Short glass tube.

Make six tubes of tin 2½" long and ¾" in diameter, one Y tube ¾" in diameter, and one small tube for attaching pump tube to can. Solder two of the large tubes and the small tube on to the can as shown. Solder on guage wire, and attach metal screen in can to prevent soda lime coming out into lower valve. Then drill holes in the rubber stoppers so that one can be placed on each of the tubes attached to the can and on two of

* Used in Lincoln School Research Study entitled, "Teaching Nutrition in Biology Classes," Bureau of Publications, Teachers College, Columbia University, 1939.



Respiration Apparatus

the other large metal tubes. Put the rubber valves on the metal tubes so that air will pass from the can to the hose at the top and from the hose to the can at the bottom opening. Assemble glass chimneys over the valves. Attach the two valves to the Y by two 16″ pieces of tubing and put the remaining 4″ piece of tubing on the Y tube. The two other metal tubes can be used as mouth pieces and sterilized between successive measurements.

To operate the respiration apparatus have patient place mouthpiece in mouth and hold it there while breathing through his nose. Attach the oxygen tank and fill container with oxygen. Remove hose connected to oxygen tank and attach pump. If no more accurate means is available, the pump can be calibrated by measuring the volume of air each pumpful furnishes when such air is collected by displacement of water from an inverted graduated cylinder held over a water bath.

When everything is in readiness have the patient start breathing through his mouth. Another pupil can hold his nose. Time is counted from the first exhalation which fails to make the rubber cap touch the wires. Air is pumped in to the can to replace the oxygen used by the patient. The operator adds just enough air to make the cap touch the guage wire each time the patient exhales. The test should continue for about five minutes. Since the exhaled carbon dioxide is absorbed by the soda lime, the quantity of air pumped into the apparatus during the test is equivalent to the amount of oxygen used by the subject during the test. Experiments have shown that each cubic centimeter of oxygen consumed is the equivalent of 0.004825 calories. Thus the results can be translated into calories expended. Total daily expenditure can be calculated if we assume, for purposes of comparison, the rate of expenditure observed during the test.

The observations should include a record of the number of pump fulls of air required and of the number of minutes duration of the test. From this should be calculated the cubic centimeters of oxygen used during the test, the number of cubic centimeters of oxygen used during a day, the calories expended per day, and the calories expended per pound of body weight per day. Students find it very interesting to compare their rates of expenditure. Several stimulating periods can be spent in performing these tests and in interpreting the results obtained.

News and Notes

KANSAS ASSOCIATION

A twelve page attractive booklet of the Kansas association contains the constitution, lists of officers and committees and a full list of the charter members of the association. This publication has been sent out by their secretary-treasurer, Miss Gladys Beck, Wyandotte High School, Kansas City, Kansas. The first meeting was held in November at Topeka when Dr. D. F. Miller of Ohio State University was the guest speaker. This meeting was held in connection with the annual meeting of the state teachers association.

THE DETROIT BIOLOGY CLUB

The officers elected last spring for this year are: President, Hessel W. Tenhave, Sr. High School, Royal Oak, Mich.; Vice-President, Ethel Godfrey, Dwyer Intermediate, 1111 Caniff, Detroit; Secretary, Florence Maxwell, Jackson Intermediate, 4180 Marlboro, Detroit; and Treasurer, Clair Pocklington, Sr. High School, Highland Park, Mich.

THE BIOLOGY TEACHERS CLUB OF SOUTHWESTERN PENNSYLVANIA

Frick Park near Pittsburgh was the location for the Nature Hike that started off the official year for the biology teachers of Pittsburgh and vicinity. This meeting proved to be a good start for this active group. The president, Mr. Clifford Winnette of Canonsburg, Pennsylvania, reflects the general enthusiasm of his group.

WEST CENTRAL INDIANA BIOLOGICAL SOCIETY

Dr. W. P. Allyn, professor of biology, Indiana State Teachers College, Terre Haute, Indiana, addressed the society on the cultural aspects of biology. Dr. Allyn stressed the fact that the ability to quote literature and to speak foreign languages was not the only form of culture, but that the person who knows something of birds, insects and other natural phenomena has something of practical value which may have at least as great an importance to society. Professor Allyn also emphasized that the way to put biology into its rightful position is to make it of service to our citizens.

The meeting was held in the science building of the Terre Haute College on Oct. 9th and presided over by Mr. Paul K. Turner, President.

GREATER CLEVELAND BIOLOGY SOCIETY

On October 13th, Professor Paul Visscher, of Western Reserve University, Cleveland, Ohio, spoke to the Greater Cleveland Society on the topic "The Teaching of Science in Our Changing World." This was the first meeting of the society this fall and indications are good for a splendid series of programs during the year. Mr. James C. Adell is president of this growing society.

In New York City on November 3rd and 4th was held the second conference of an attempt to coordinate the numerous interests and activities in health education. Our association was invited to send a delegate.

INDIANA BIOLOGY TEACHERS

On Thursday, October 26th, Mr. Prevo L. Whitaker of Terre Haute, Indiana, Secretary-treasurer of the West Central Indiana Biological Society, spoke before the biology section of the Indiana Teachers Association in Indianapolis on the subject of the work of the National Association of Biology Teachers. Mr. Whitaker distributed leaflets and sample copies of the journal.

On the same day our association was presented to the biology section of the Northern Indiana Teachers Association by Mr. Howard H. Michaud, President, and Mr. A. B. Krom, Secretary, of the Northern Indiana Biology Teachers Association.

Breeding Times of Animals

(Continued from page 67)

is due to a reaction against foreign proteins administered with the hormones, others to anti-hormones; but no foreign proteins are involved in the refractoriness to light shown by all sexually photoperiodic animals so far investigated. The resistance seems to develop in the sex-gland and then pass off.

Benoit then showed that ducks respond to changes in length of day, to reds and yellows but not to greens and blues, like starlings do, and that the eyes are the receptors for the light effects. Covering the eyes, but not the rest of the body, cuts off the action. But the regions of the head around the eyes, the cut stumps of optic nerves and even the hypophysis itself are effective receptors for the light effect in ducks. We found the eyes the receptors in ferrets but that cutting the optic nerves prevented the reception of sexually activating light. The eyes also are receptors in sparrows.

Miyazaki showed that the green mejiro of Japan can be brought into breeding condition at least three times a year by "yogai" or adding illumination at night, to get it to sing its mating songs. Reduced lighting induced moulting.

Scott and Payne in Kansas induced turkeys to mate and lay fertile eggs in January instead of March by night-lighting; but failed to get activation if the light was merely added as increased intensity during the daylight hours. Red light was the effective type. Guinea fowl failed to respond. They were originally tropical animals as were Guinea pigs, which also fail to respond.

We have induced pheasants and bob-white quail to lay fertile eggs out of normal season by use of experimental night-lights, and Leonard, Clark and Bump induced sexual activation in these birds and in grouse as well. Others have done the same for quail and pheasants.

By applying the experimental methods outlined above, we have induced pheasants to lay fertile eggs from January 15 onward with increasing periods of night-lighting begun on December 16. Three hens produced an average of over 105 eggs each before they layed themselves to death about the end of June. Chicks hatched on May 7 from some of these early induced eggs were induced by night-lighting, begun at 151 days of age, to lay fertile eggs at 185 days of age from November 8 onward, with chicks hatched from these eggs on Christmas day. One of two surviving chicks from these Christmas ones laid two eggs on July 25 and 26 of the following summer without night lighting (203 days). This shows that, but for the seasonal reduction of daily light periods, pheasants could lay at about 200 or fewer days of age, whereas they do it only at about nine or

ten months at best, from the first week in April onward (332 days).

With night-lighting begun in January, ring-neck, black-neck and Mongolian pheasants have been induced to lay numerous fertile eggs, and, when returned to days of normal length and suitable cover in early April, they have started laying again at a slower rate, after a pause. After laying some eggs loose at random in the pens they have built nests and begun incubation of eggs laid in them. High percentages of fertility and hatch have been obtained from these eggs. This will enable pheasants to be used under lights, to get many early fertile eggs for setting, and then released or "planted" in the wild to raise a brood of their own without cost thereafter. It has been found also that one cock may be used effectively with eight or more hens, under lights.

We have recently shown that the blue jay is also susceptible to modification of its breeding cycle by altered light schedules. The weaver-bird has also been shown by Brown and a collaborator to have its breeding cycle modifiable by light-manipulation after its first year in which it does not breed. This is contrary to Witschi's findings; but it is possible that his experiments leading to negative results were carried out on juvenile birds without realizing that they breed first in their second year of life.

Murphy has pointed out that storks forcibly retained in the southern hemisphere, through times of their normal northward migrations to breeding grounds in Europe, may breed in the south. This is important as indicating that their northward migration is dependent upon a phase of the cycles of their glands of internal secretion, probably the pituitary, upon which also the activation of the sex-glands depends. The migration reaction may be prevented from accomplishment without stopping the chain of reactions which ultimately leads to mating and rearing of young. The internal cycle goes on even when one or more phases of its external manifestations are prevented if such prevention is not concerned with the major or fundamental conditioning factor. Hann has recently found that juncos, towhees and white-throated sparrows migrate even after castration and in some cases at least return to northern habitats. These findings are in accord with my suggestion that the migration urge probably depends on the anterior pituitary which also controls the sex-glands. Migration urge is set off by an earlier phase of pituitary activation than is gonadal activation or parallels the very early stages of such activation.

A discussion of similar studies on fish, amphibians, reptiles and mammals, which confirm much of what has been told of birds, but with many specific differences, must be left for the future, but one must bear in mind after reading the foregoing that not all birds or other animals are sexually conditioned by light-cycles or photoperiodic changes. Of those that are, some react or are activated by increasing, others by decreasing daily light-time. Some seem to rely upon light-time alone or almost alone; others on some other factors in addition to it or instead of it. Much more study is needed to elucidate the whole problem or delineate the picture so aptly noted by Tennyson in the stanzas with which we started. Each species must be tested and its peculiar specific reactions in this regard recorded. So sometime we may be able really to control breeding cycles for the pleasure and benefit of mankind and make the most of the animals over which we gain this added control.

BOOKS

KROEBER, ELSBETH, AND WOLFF, WALTER H. *Adventures with Living Things.* D. C. Heath and Co., 1938, pp. xiii + 798.

Mechanical Make up: The publishers of *Adventures with Living Things* contributed a durable cover, a strong binding, and an effective cover design. The cuts and half tones used by the authors to illustrate their various topics are conspicuous for their thoroughness and effective supplementation of the type and reading matter of the text. One notes the extraordinary number of sources the authors used to glean their illustrations. Almost every illustration is excellently supplemented by labels and stimulating legends.

Literary Style: The authors follow up the active approach indicated in the title by use of a very dynamic style. The language is clear and concise and the appeal is made personally to the student. Sentences like "Have you ever watched the goldfinch fly?" and "Your protoplasm is not identical with mine" are likely to make for keen interest on the part of the pupil.

The average high school pupil should have no difficulty in understanding this book although where the topics are more difficult—*e.g.,* mutations, genetics—the sentences are longer and the language more difficult. This, no doubt, is unavoidable and since the pupils are usually in the tenth year or above they should be quite able to master this style.

For the most part *Adventures with Living Things* can be read with ease and pleasure. Excessive technical terminology is avoided. Where necessary terms are introduced they are appropriately explained and are given adequate repetition.

Subject Matter: The material included in this text has been copyread by many authorities from different sections of the United States. The level of factual material in sections I and II are within the comprehension of secondary school pupils. Section III is more advanced and its factual matter is well selected for the advanced high school pupil. Part I is a descriptive account or survey of Biology. It serves to provide a background of information on which the students may think effectively about the living things surrounding them. Part II takes up the life functions and interrelationships of organisms. These chapters are organized in units.

Part III presents the so-called great generalizations or principals of biology. This material is also presented in units, but statements of generalizations take the place of the unit questions of Part II.

Psychological Soundness: Any modern textbook of science, if carefully organized from the pupils' viewpoint, must be planned in terms of the needs of the student so that he feels the significance of the materials presented. *Adventures with Living Things* has been written with this psychological point of view in mind. The approach of the authors through the entire text is to present problems and set up a method by questions, experiments, and classroom activities, whereby, the pupils might draw an understanding of the problem.

In the preface the authors state that the text has been organized so as to im-

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(Smith, R. C., Jour. Ec. Ent. 31 (5): 564. N 11, 1938.)

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ply and incorporate the scientific attitudes of mind. It is felt more provision should have been made, however, to train and test for any scientific attitudes that may be developed.

Pupil Activities: To observe the new trend in biology textbook writing, centering our attention on pupil activities we should select this text as a good illustration of progress made. Each chapter has its survey questions in the form of problems. Further there are three types of pupil activities at the end of each problem: Exercises, Problems for Classroom Discussion, and Activities for the Junior Biologists. When one examines each type separately one finds the best educational and psychological experiences pooled.

"Problems for Classroom Discussion" are comparable to the old type end chapter questions, but here the authors have combined years of teaching experience plus the experiences of co-workers and have selected the best available, most stimulating and challenging questions.

"Activities for the Junior Biologists" are definitely for the superior students. Its inclusion is in accordance with the modern trend in providing for individual differences. These carefully planned activities practically presuppose the availability of a science project room.

The authors have compiled a list of enticing adventure books in biology after each chapter under the title "Good Books to Read." Provisions for pupil activities discussed above makes *Adventures with Living Things* a superior text and points to the modern and future trend in biology textbook writing.

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Lumley, Ellsworth D. *The Two Eagles of North America.* New York Emergency Conservation Committee, 1939, pp. 22.

This is a third unit in the conservation series and is written for use in schools, scouts, and other study groups. The author decries the unwonted destruction of the Golden Eagle and the indigenous Bald Eagle. He analyzes the common myths associated with the so-called predatory nature of these two magnificent birds and shows them to be concoctions of the imaginations of an isolated few. None of the stories of attacks on babies, game, fish, have ever been confirmed. The two eagles are basically scavengers and are most useful in this respect.

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Experience Units in Biology. FAUST & BIECHER. Stackpole Sons. $1.20 on two or more copies. Mastery Tests on same.

A Bibliography of Nature Study. EVA L. GORDON. Comstock Publishing Company. 25¢.

Conservation in the U. S. GUSTAFSON, RIES, GUISE, HAMILTON. Comstock Publishing Company. 444 pages. $3.00.

Handbook of Nature Study. ANNA BOTSFORD COMSTOCK. Comstock Publishing Company. 930 pages. $4.00.

Field Book of Animals in Winter. ANN HAVEN MORGAN. G. P. Putnam's Sons. 525 pages. $3.50.

A Laboratory Guide in Entomology. ROBERT MATHESON. Comstock Publishing Company. 135 pages. $2.00.

Thoreau—Reporter of the Universe. BERTHA STEVENS. The John Day Company. 228 pages. $2.50.

Ascaris—The Biologist's Story of Life. RICHARD GOLDSCHMIDT. Prentice-Hall. 390 pages. $3.25.

Seeing the Unseen. ROBERT DISRAELI. The John Day Company. 155 pages. $2.50.

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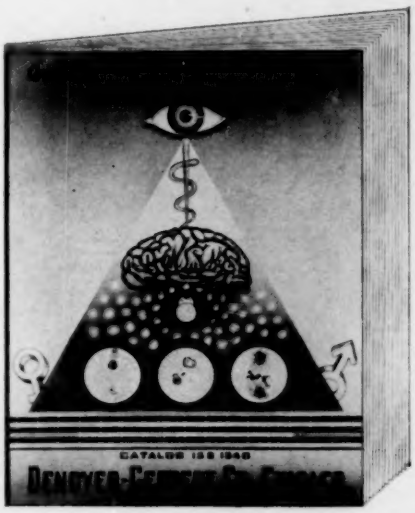

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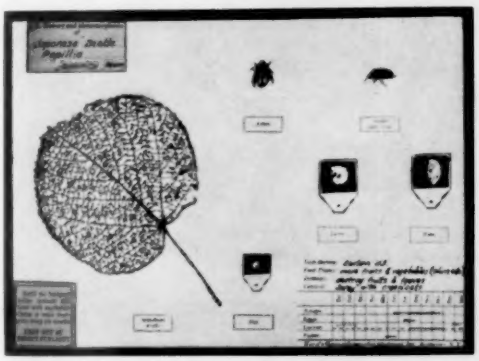

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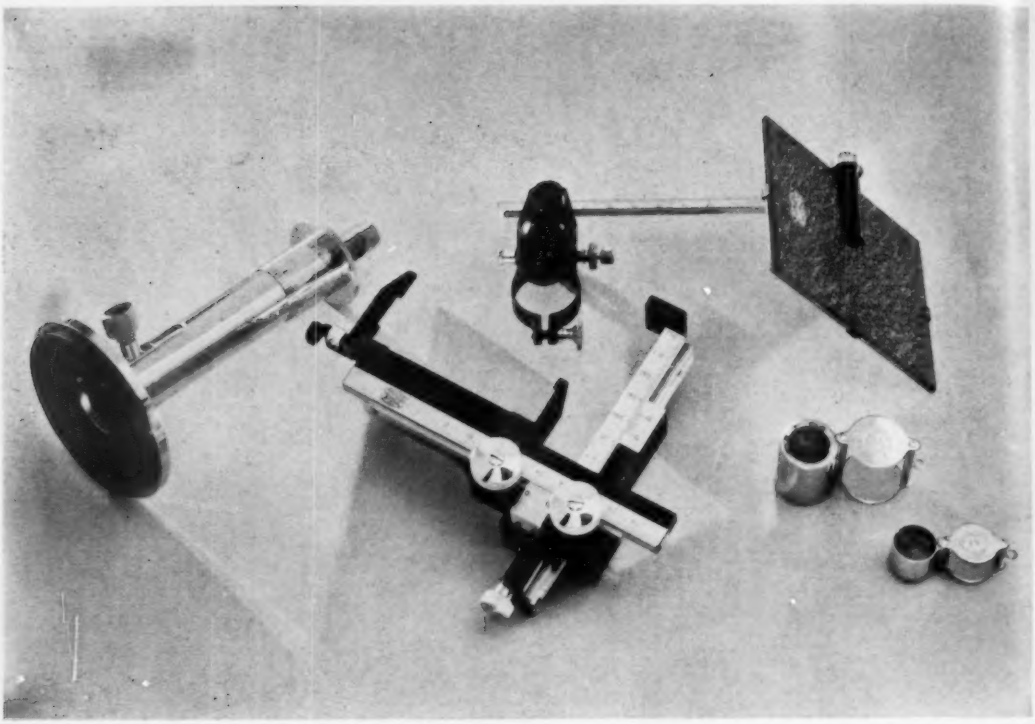

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